

ENHANCEMENT EVALUATION TECHNIQUES FOR
ARCTIC GRAYLING (*Thymallus arcticus*)
IN ALASKA, 1986

By: Alan C. Havens



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ABSTRACT

This research project was initiated to improve stocking practices of hatchery reared Arctic grayling (*Thymallus arcticus* Pallus) in landlocked lakes. Two Matanuska-Susitna Valley lakes that contained populations of threespine stickleback (*Gasterosteus aculeatus* Linnaeus) were stocked with 1.24 gram fingerling Arctic grayling. Grayling survival to age 1 was ten percent in Sliver Lake and one percent in Wolf Lake. These survival rates were considerably lower than the 59 percent survival estimated in 1985 for age 1 Arctic grayling stocked as 2.7 gram fingerlings in stickleback-free Canoe Lake.

Two additional lakes containing no threespine sticklebacks were stocked with two size groups of age 1 Arctic grayling (0.017 gram fry and 1.24 gram fingerlings). In these lakes, relative survival from stocking to the following summer was significantly greater for grayling stocked as fingerlings than those stocked as sac-fry.

KEY WORDS: southcentral Alaska, stocking practices, Arctic grayling, *Thymallus arcticus*, threespine stickleback, *Gasterosteus aculeatus*, survival estimates, fish growth.

INTRODUCTION

Selected landlocked lakes in southcentral and interior Alaska have been stocked with hatchery reared game fish since 1952. Currently landlocked lakes in the Matanuska-Susitna Valley of southcentral Alaska (Figure 1) are stocked on an annual or every other year basis. The majority of these lakes, ranging in size from 7.2 to 362 surface acres, were barren or contained only threespine stickleback (*Gasterosteus aculeatus* Linnaeus) prior to stocking. Several game fish species - rainbow trout (*Salmo gairdneri* Richardson), coho salmon (*Oncorhynchus kisutch* Walbaum), and Arctic grayling (*Thymallus arcticus* Pallus) - have been stocked to provide a diversity of fishing opportunity.

Until recently Arctic grayling played a relatively minor role in the Matanuska-Susitna Valley stocking program. Prior to 1984, only grayling fry (0.017 grams each), hatched from "wild" eggs at state hatcheries, were available for stocking. Susceptibility to predation limited fry stocking to barren lakes or lakes that had been chemically treated to eliminate stickleback. From 1968 through 1983 just four landlocked Matanuska Valley lakes were stocked with grayling fry on a regular basis.

Estimated survival of Arctic grayling fry to fingerling size, stocked in barren ponds in interior Alaska, ranged from 5% to 34% (Peckham and Ridder 1979; Ridder 1985). Percent survival of grayling 3 months after being stocked as sac-fry in a chemically treated Matanuska-Susitna Valley lake was 1.9% and 2.2% in 2 successive years (Havens 1985, 1986).

In 1984, personnel at the Alaska Department of Fish and Game Clear Hatchery, using commercially available fish food, reared sufficient numbers of grayling fingerlings to support a stocking program. This

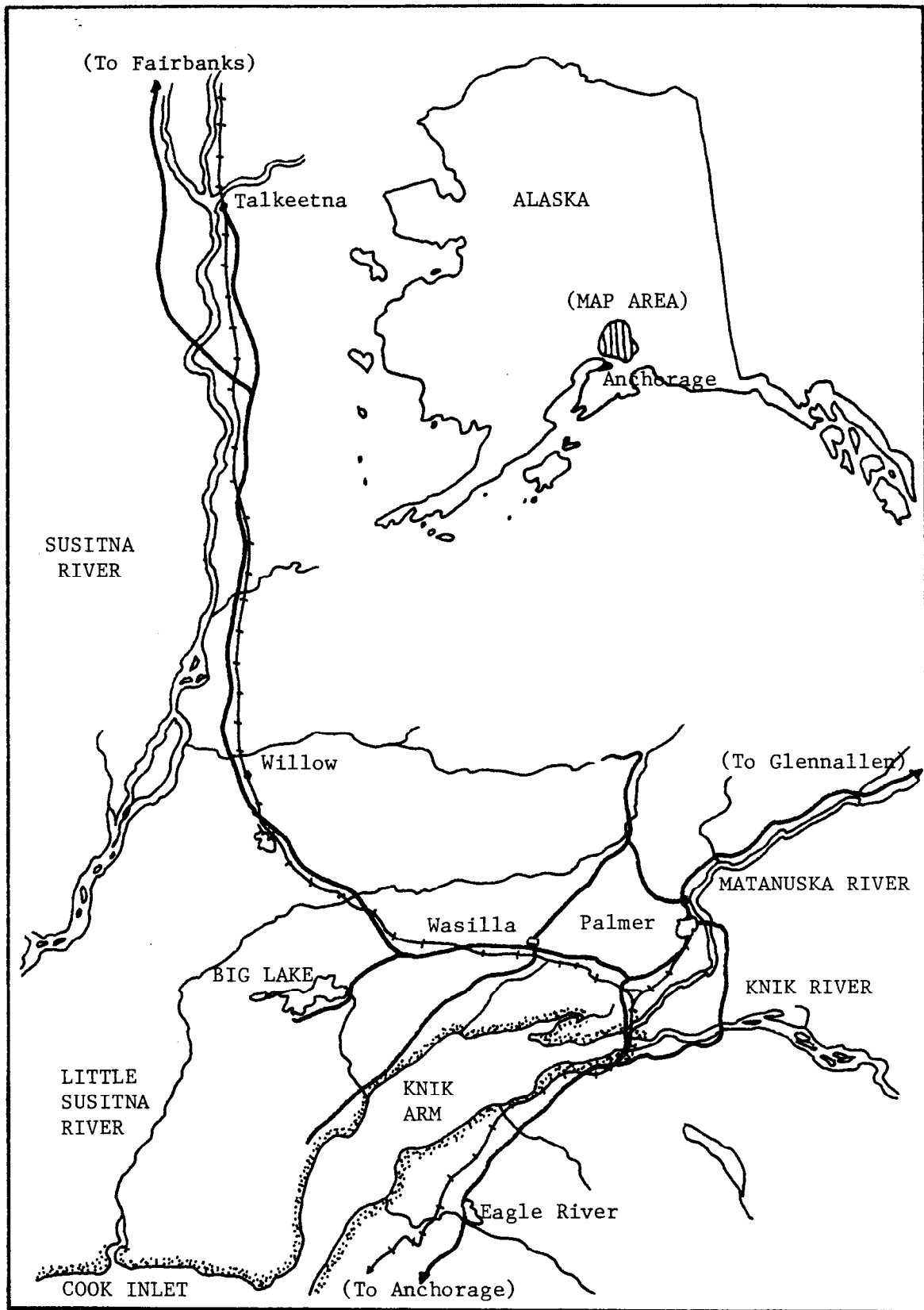


Figure 1. Study Area of the Matanuska-Susitna Valley.

development spurred new interest in grayling stocking research to: (1) compare survival to catchable size of grayling stocked as fry versus fingerlings in lakes both with and without competitor/predator species, and (2) determine the most efficient stocking densities based on survivals, hatchery rearing costs, and impact on the wild grayling resource as related to egg take needs. If fingerling plants are successful in stickleback-infested lakes, the options for creating new fisheries or multiple species fisheries in heavily utilized roadside lakes in southcentral Alaska would be greatly expanded.

Objectives of this study were:

- (1) to compare the abundance (relative survival) and mean length at age 1 of Arctic grayling stocked as fry and fingerlings in Canoe and Meirs Lakes; and
- (2) to estimate the survival and mean length at age 1 of Arctic grayling stocked as fingerlings in stickleback-infested Sliver and Wolf Lakes.

METHODS AND MATERIALS

Four Matanuska-Susitna Valley landlocked lakes were stocked with Arctic grayling in 1985 for experimental purposes as well as to provide fish for recreational anglers (Table 1). Meirs and Canoe Lakes were each stocked with 0.017 gram (approximately 14 mm) grayling fry from Moose Creek broodsource in June 1985 and 1.24 gram (approximately 52 mm) grayling fingerlings from Jack Lake broodsource in September 1985. In subsequent sampling, the fry and fingerling Arctic grayling were distinguished by size (Havens 1986). Sliver and Wolf Lakes, both containing endemic populations of threespine stickleback, were stocked with 1.24 gram grayling fingerlings from Jack Lake broodsource in September 1985.

Lake Descriptions

Meirs Lake (16.8 surface acres) has been stocked with hatchery fish on a regular basis since 1958 but contained no fish species in June 1985 due to a complete winterkill in March 1985 (Havens 1986).

Canoe Lake (21.2 surface acres) was chemically treated to eliminate threespine stickleback in 1965 and has been stocked with hatchery fish on a regular basis since 1966. In June 1985 Canoe Lake contained both Arctic grayling and rainbow trout stocked in prior years.

Sliver Lake (7.2 surface acres) had been stocked with rainbow trout fingerlings from 1980 to 1982. However, rainbow trout survival to catchable size was minimal due to competition with threespine stickleback and low winter dissolved oxygen levels (Havens 1984). Sliver Lake was chemically treated with rotenone in October 1983, prior to ice-up, to eliminate threespine stickleback. However, rehabilitation attempts were unsuccessful as stickleback were observed in openwater spring areas in March 1984.

Table 1. Stocking summary for Arctic grayling in selected Matanuska-Susitna Valley lakes, 1985.

Lake	Stickleback Present	Surface Area (acres)	Date Stocked	Number Stocked	Stocking Size		Stocking Density (Fish/acre)
					(g)	(mm)	
Canoe	No	21.2	06/12/85	32,500	.017	14	1,533
			09/03/85	4,240	1.24	52	200
Meirs	No	16.8	06/12/85	12,700	.017	14	756
			09/03/85	3,360	1.24	52	200
Sliver	Yes	7.2	09/03/85	1,440	1.24	52	200
Wolf	Yes	62.0	09/03/85	12,400	1.24	52	200

Wolf Lake (62 surface acres) was stocked with 13,765 fingerlings coho salmon in May 1984. Test netting in 1984 also documented the presence of older coho salmon, Dolly Varden, rainbow trout, and threespine stickleback. It is assumed that these species either entered the lake through a high water inlet or were illegally transported to Wolf Lake by fishermen.

Sampling and Analysis

During the summer following stocking, Arctic grayling in each lake were captured for population sampling using fyke nets. The fyke nets were 9 feet long, 30 inches in diameter, and included two 3-foot x 20-foot wings (two square aluminum frames and six steel or aluminum hoops supported the entrance and the body of the fyke net). Internal throats, body, and wings were of 3/16-inch square mesh knotless nylon. In each lake, eight to twelve fyke nets, baited with salmon eggs, were set parallel to the shoreline and fished for approximately 20 hours each.

In Canoe and Meirs Lakes, all captured age 1 grayling were placed in a tub, oxygenated with a portable 20-pound oxygen bottle, and anesthetized with equal parts of MS-222 and Quinate. Total catch of age 1 grayling from each stocking class (fry and fingerlings) was recorded for each trap in each lake. All fish were then placed in a 4-foot x 4-foot x 8-foot covered holding pen. A sample (100, or the number captured) of age 1 grayling were dip-netted from the holding pen and measured to the nearest millimeter fork length. All fish were then released. A chi-square goodness of fit test was used to compare fyke net catches (abundance or relative survival to age 1) of the two stocking sizes (sac-fry versus 1.24 gram fingerlings) in Canoe and Meirs Lakes.

In Sliver and Wolf Lakes, age 1 grayling were captured using the fyke nets fished for a total of 6 or 7 consecutive days. All grayling captured were recorded by fyke net and measured to the nearest millimeter fork length. Grayling captured for the first time were marked with an adipose fin clip and then released in the middle of the lake. Marked and unmarked grayling were enumerated during subsequent sampling.

Total grayling abundance in Sliver and Wolf Lakes was estimated using Chapman's modification of the Schnabel multiple census estimate of population size (Ricker 1975). Percent survival was estimated as the proportion of the original number of fingerlings stocked surviving to age 1.

RESULTS

Arctic Grayling Fry Versus Fingerling Survival

Meirs Lake was stocked with 12,700 Arctic grayling sac-fry and 3,360 grayling fingerlings in June and September 1985, respectively. During fyke net sampling in May 1986, 361 grayling stocked as fry and 226

grayling stocked as fingerlings were captured (Table 2). Survival to age 1 of fingerlings was significantly greater than that of sac-fry ($X^2 = 113.26$, $df=1$, $P<0.05$).

In Canoe Lake, 32,500 Arctic grayling fry and 4,240 grayling fingerlings were stocked in June and September 1985, respectively. During fyke net sampling in May 1986, 28 grayling stocked as sac-fry and 369 grayling stocked as fingerlings were captured (Table 2). As with Meirs Lake, percent survival to age 1 of fingerling grayling was significantly greater than that of sac-fry ($X^2=2,593.38$; $df=1$, $P<0.05$).

Fingerling Survival In Stickleback Lakes

Sliver Lake was stocked with 1,440 Arctic grayling fingerlings (1.24 gram) on 3 September 1985. During subsequent sampling from 3 June to 27 June 1986, 99 grayling were captured and marked, of which 46 were recaptured (Appendix B). The estimated population was 149 fish with a 95% confidence interval from 129 to 174 fish (Table 4). The estimated percent survival from stocking to age 1 was 10.35% with a 95% confidence interval from 8.96% to 12.08%. During the 6 day sampling period, an average of 24 grayling were captured by fyke nets each day; the average number of threespine stickleback captured each day was 2,450.

Wolf Lake was stocked with 12,400 Arctic grayling fingerlings on 3 September 1985. During fyke net sampling for one night in October, 16 age 0+ Arctic grayling (60 mm - 72 mm), 501 age 1+ coho salmon (128 mm - 300 mm), eight age 2+ and older coho salmon (321 mm - 485 mm), one Dolly Varden (395 mm), one rainbow trout (203 mm), and several thousand threespine stickleback were caught. Forty-five grayling were marked and six recaptured during 7 nights of sampling from 30 May through 3 July 1986 (Appendix B). The estimated population was 129 grayling with a 95% confidence interval from 110 to 233 fish (Table 4). The estimated percent survival from stocking to age 1 was 1.04% with a 95% confidence interval from 0.89% to 1.88%. During the 7 day sampling period an average of nine grayling were captured by fyke nets each day; the average number of coho salmon captured each day was 86, and the average number of threespine stickleback captured was 5,525.

Fry and Fingerling Growth

Arctic grayling stocked as sac-fry were significantly larger after one growing season in the two lakes containing no sticklebacks than were grayling stocked as fingerlings (Table 3). Age 1 grayling that had been stocked as fry on 12 June 1985 in Meirs Lake averaged 184.03 mm while in Canoe Lake their average length was 183.52 mm. The grayling that had been stocked as fingerlings on 3 September 1985 in Meirs Lake averaged 106.36 mm while in Canoe Lake their average length was 106.56 mm. However, grayling stocked as fingerlings in lakes containing stickleback populations grew much slower than fingerlings stocked in the barren lakes. In both Wolf and Sliver Lakes the average length of grayling was only about 77 mm (Table 3).

Table 2. Fyke net catch data for 1985 stocked Arctic grayling in Canoe and Meirs lakes, 1986.

Lake	Date Stocked	Number Stocked	Stocking Size (g)	Stocking Density (fish/acre)	Sample Date	Number Caught
Canoe	06/12/85	32,500	.017	1,533	05/29/86	28
	09/03/85	4,240	1.24	200	05/29/86	369
Meirs	06/12/85	12,700	.017	756	05/21/86	361
	09/03/85	3,360	1.24	200	05/21/86	226

Table 3. Length data for Arctic grayling (stocked in 1985) in Canoe, Meirs, Sliver, and Wolf lakes.

Lake	Stocking Date	Stocking Size		Sample Date	Number Sampled	Length Range (mm)	Mean Length (mm)	Standard Error
		(g)	(mm)					
Canoe	06/12/85	.017	14	05/29/86	27	161 - 206	183.52	1.97
	09/03/85	1.24	52		100	78 - 131	106.56	1.08
Meirs	06/12/85	.017	14	05/21/86	100	155 - 213	184.03	1.02
	09/03/85	1.24	52		100	83 - 132	106.36	1.14
Sliver ¹	09/03/85	1.24	52	06/04/86	30	62 - 87	75.53	1.16
Wolf ¹	09/03/85	1.24	52	05/30/86	24	68 - 91	77.88	1.07

¹ Sliver and Wolf Lakes contain populations of threespine stickleback.

Table 4. Population estimates for Arctic grayling (stocked in 1985) in Sliver and Wolf lakes.

Lake	Date Stocked	Number Stocked	Stocking Size (g)	Sample Dates	Population Estimate	Survival	95% Confidence Level	
							Estimate	Survival
Sliver	09/03/85	1,440	1.24	06/03/86 - 06/27/86	149	10.35%	129 - 174	8.96% - 12.08%
Wolf	09/03/85	12,400	1.24	05/30/86 - 07/03/86	129	1.04%	110 - 233	0.89% - 1.88%

DISCUSSION

In both Meirs and Canoe Lakes, the survival of grayling stocked as fingerlings was significantly higher than for grayling stocked as fry. The relatively higher ratio of surviving sac-fry grayling in Meirs Lake than Canoe Lake was probably because Meirs lake was barren at the time of stocking whereas both rainbow trout and grayling were present in Canoe Lake.

Results of the 1986 Meirs and Canoe Lakes experiments are similar to those reported by Havens (1986) for a 1985 Canoe Lake stocking experiment which compared the survival to age 1 of 13,000 grayling stocked as 0.014 gram fry in June 1984 to 4,200 grayling stocked as 2.7 gram fingerlings in August 1984. In this study, apparent survival of fingerlings was also significantly greater than that of sac-fry ($P < 0.05$).

The presence of threespine stickleback appeared to have a major affect on survival of grayling stocked as fingerlings. This is apparent both in total survival estimates as well as in fyke net catch rates. Initial fyke net catch rates for Arctic grayling that had been stocked as fingerlings in stickleback-infested Sliver and Wolf Lakes were only 0.11 and 0.16 fish per fyke net hour, respectively. In stickleback-free Meirs and Canoe Lakes, on the other hand, fyke net catch rates were 1.49 and 1.93 stocked fingerling per fyke net hour, respectively. Survival rates in Sliver and Wolf Lakes of grayling stocked as fingerlings were low (approximately 10% and 1%, respectively) when compared to the 59% survival of 2.7 gram grayling fingerlings in Canoe Lake reported by Havens (1986). The effect of stickleback competition was also apparent in the much smaller average size achieved by grayling stocked in Sliver and Wolf Lakes.

Past research with stocked rainbow trout in Matanuska-Susitna Valley landlocked lakes indicates that the established, more abundant stickleback populations represent a serious competitive challenge to non-indigenous game fish that have not previously been subjected to the selection process of the natural environment. Threespine stickleback population estimates in 1982 (Havens et al. unpublished; Havens 1983) revealed stickleback densities ranging from 3,800 to 36,000 per surface acre and stickleback mean weights ranging from 0.5 grams to 1.5 grams in lakes normally stocked with fingerling game fish at densities of 200 per surface acre.

Studies by Havens (1982) and Wenderoff (1982) comparing relative survival and growth of rainbow trout in two stickleback-infested lakes and a rehabilitated (stickleback-free) lake indicated superior survival and growth of trout stocked in the rehabilitated lake. Examination of gut contents of rainbow trout fingerlings and sticklebacks suggested that food competition existed; as both species utilized the same food organisms but in differing proportions. In the rehabilitated lake, rainbow trout fingerlings, lacking inter-species competition, fed mainly on zooplankton from the time of stocking in late summer through the following spring. In the stickleback lakes, however, trout fingerlings

displayed a more varied food selection, heavily utilizing insects and benthic organisms in addition to zooplankton, while zooplankton appeared to be the most important food item for sticklebacks throughout the year.

Havens (1984), summarizing data collected from several experiments on stocked rainbow trout, reported that survival to age 1 for rainbow trout fingerlings stocked at a weight of about 1 gram ranged from 8% to 35% and averaged 24% in stickleback-infested lakes. In lakes not containing stickleback, survivals ranged from 11% to 61% and averaged 36%. Rainbow trout growth was also slower in lakes containing sticklebacks than in stickleback-free lakes. Stocking hatchery reared rainbow trout fingerlings at a size of 2 grams rather 1 gram increased the survival to age 1 from an average of 24% to 36% in stickleback lakes and from 36% to 50% in lakes free from stickleback.

Thirty-one of the 50 Matanuska-Susitna Valley lakes stocked with non-anadromous game fish in 1986 contained populations of threespine stickleback and virtually all other lakes that will be stocked in the future contain stickleback. Chemical rehabilitation of landlocked lakes does not appear to be the best solution for increasing stocked game fish survival and growth because of high cost (the average cost to chemically treat a lake with rotenone is \$180 per surface acre) and questionable success. Between 1953 and 1983 a total of 23 of the Matanuska-Susitna Valley lakes currently stocked were chemically treated at least one time to eradicate stickleback. Stickleback reappeared in 13 of these lakes due to reintroduction or failure to completely eliminate all fish.

Increasing the stocking size of hatchery reared rainbow trout, coho salmon, and Arctic grayling fingerlings may prove to be more cost efficient and reliable method of improving survival. Investigation of Arctic grayling survival and growth in landlocked lakes is being continued: grayling fry at 2,000 per surface acre, and 4 gram and 6 gram fingerlings, each at 100 per surface acre, were stocked in two stickleback-free and two stickleback-infested Matanuska-Susitna Valley lakes in 1986. An additional four lakes in Glennallen and four lakes near Fairbanks received similar experimental plants of grayling in 1986. All lakes will be sampled in spring 1987 to compare relative survival and growth of the three grayling stocking sizes.

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APPENDIX A

Appendix Table A1. Length measurements for 1985 stocked Arctic grayling sampled in Meirs Lake, May 1986.

Arctic Grayling Stocked As:					
Fingerling			Fry		
Length (mm)	Length (mm)	Length (mm)	Length (mm)	Length (mm)	Length (mm)
83	103	113	155	179	190
83	103	113	160	180	190
84	103	114	165	180	190
86	104	114	166	180	190
86	104	114	168	180	191
87	104	114	169	180	192
87	104	115	172	181	192
87	105	116	173	181	192
88	105	116	173	181	192
91	105	116	173	181	192
91	105	116	174	182	193
91	105	116	174	182	193
93	106	117	175	182	193
93	106	118	175	183	194
94	107	118	175	183	195
94	107	118	176	183	195
94	107	118	176	183	196
94	108	119	176	183	196
95	108	120	176	183	197
95	109	120	177	183	198
96	109	122	177	183	198
96	110	122	177	183	198
97	110	124	177	183	200
97	110	124	177	184	200
97	110	124	177	184	201
98	110	125	177	185	202
98	111	126	178	186	204
100	111	127	178	187	206
101	111	129	178	187	207
101	111	132	178	187	213
101	112		178	187	
101	112		178	188	
101	112		178	188	
101	113		178	189	
102	113		179	189	

Appendix Table A2. Length measurements for 1985 stocked Arctic grayling sampled in Canoe Lake, May 1986.

Arctic Grayling Stocked As:			
Fingerling			Fry
Length (mm)	Length (mm)	Length (mm)	Length (mm)
78	102	113	161
83	103	113	167
87	103	114	171
88	103	114	173
91	103	114	175
92	104	114	175
92	104	115	177
93	104	115	178
93	104	116	178
94	105	117	179
94	105	117	181
94	105	117	183
94	106	118	184
94	106	118	185
94	107	118	185
95	107	118	185
95	108	119	186
95	108	119	187
95	108	120	188
96	108	121	188
96	108	121	189
97	109	122	189
98	109	123	191
98	109	123	193
98	109	124	196
98	110	125	205
98	110	125	206
98	110	127	
99	111	128	
100	111	131	
100	111		
100	111		
100	112		
101	112		
102	112		

Appendix Table A3. Length measurements for 1985 stocked Arctic grayling sampled in Sliver and Wolf Lakes, May and June 1986.

Sliver Lake	Wolf Lake
Length (mm)	Length (mm)
62	68
65	73
67	73
68	73
69	73
71	74
71	74
71	75
72	75
72	75
73	76
73	76
74	77
74	78
74	79
74	80
75	80
77	81
78	82
78	82
80	83
80	83
81	88
82	91
82	
83	
84	
84	
85	
87	

APPENDIX B

Appendix Table B1. Number of Arctic grayling captured, marked and recaptured, by date, for the Sliver Lake population estimate, 1986.

Number Date	Number Caught	Number Recaptured	Number Marked	Marked Fish at Large
06/03/86	17	0	17	0
06/04/86	13	0	13	17
06/24/86	35	6	29	30
06/25/86	18	6	12	59
06/26/86	27	12	15	71
06/27/86	35	22	13	86
Totals:	145	46	99	

Appendix Table B2. Number of Arctic grayling captured, marked and recaptured, by date, for the Wolf Lake population estimate, 1986.

Date	Number Caught	Number Recaptured	Number Marked	Marked Fish at Large
05/30/86	24	0	24	0
06/18/86	6	1	4	24
06/19/86	8	1	7	28
06/20/86	6	2	4	35
07/01/86	4	1	3	39
07/02/86	1	0	1	42
07/03/86	3	1	2	43
Totals:	52	6	45	

